



PATENT APPLICATION

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May 24, 2004

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John C. Hammar

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: M. Kistner *et al.*

Examiner: Kenny

Appl. No.: 09/967,269

Art Unit: 3726

Filing Date: September 28, 2001

Docket: 97-064B

For: *Combined Superplastic Forming and Adhesive Bonding*

Mail Stop Appeal Brief - Patents

P.O. Box 1450

Commissioner for Patents

Alexandria, VA 22313-1450

**Brief on Appeal**

Sir:

Applicant files three copies of this Brief on Appeal within three months following filing a Notice of Appeal on February 23, 2004. Please charge the fee of \$330.00 under 37 C.F.R. §1.17(f) to Deposit Account No. 02-2960. Please also extend the period to respond one month to expire May 23, 2004 and charge the extension fee of \$110.00 to Deposit Account No. 02-2960. May 23, 2004 is a Sunday so this paper is being mailed on the next business day, May 24, 2004. If Applicant owes any other fee, please charge that fee to Deposit Account 02-2960. Please treat this paper (and any future reply) as incorporating a petition for extension of time for the appropriate length of time, in the event that an extension is required.

## **I. REAL PARTY IN INTEREST**

The real party in interest in this appeal is The Boeing Company.

## **II. RELATED APPEALS AND INTERFERENCES**

Applicant does not know of any other appeals or interferences that directly affect or will be directly affected by the Board's decision in this appeal.

## **III. STATUS OF CLAIMS**

1. Claims pending: 1 - 9
2. Claims canceled: None.
3. Claims withdrawn from consideration but not canceled: 2, 3, 5
4. Claims allowed: None
5. Claims rejected: 1 , 4 and 6 - 9
6. Claims on appeal: 1 - 9

## **IV. STATUS OF AMENDMENTS**

Applicant filed an Amendment After Final Rejection January 26, 2004, which was entered by the Examiner.

## **V. SUMMARY OF INVENTION**

The present invention combines superplastic forming (SPF) with adhesive bonding (AB) to form sandwich panel structures analogous in appearance and performance to SPF/DB panels. SPF/AB is particularly well suited for forming aluminum and its alloys, which are lower temperature processes using a material that is notoriously difficult to diffusion bond. In fact, the stable surface oxide and low oxygen solubility of aluminum alloys generally preclude diffusion bonding. Concurrent superplastic forming/adhesive

bonding (SPF/AB), however, is an acceptable alternative for aluminum and suitable, in some cases, as well for titanium. The adhesive flows during forming to produce structural bonds at all internal faying surfaces in a preferred embodiment. An air coolable, superplastic aluminum alloy and a low-volatile content/ low-viscosity adhesive with compatible forming / curing temperature and curing cycle time allow the combination of these processes. A four-sheet forming pack includes a laser welded two-sheet core separated from the face sheets by layers of adhesive. Processing conditions, especially selection of the processing temperature, balance the need for obtaining adequate superplasticity of the alloy with thermal stability of the adhesive.

This invention combines superplastic forming with adhesive bonding to produce multisheet sandwich structures. A polymer film is placed between the core sheets and the face sheets in a 4-sheet structure. The film becomes fluid during the superplastic forming process and with the assistance of the forming pressure bonds the core sheets and the face sheets creating a unitary assembly sandwich structure. Currently available aluminum SPF alloys can be superplastically formed at temperatures somewhat below 900°F. Certain polybenzimidazoles and polyamides can survive these temperatures without degradation. Degradation of polymers is accelerated in the presence of oxygen. Therefore, the use of an inert forming gas, such as argon, will improve the ability of the polymer to withstand the temperature required for the SPF process without degradation.

The SPF/AB process eliminates a tunnel void present in other multisheet structures where the sheets fold together around a weld or diffusion bond. The adhesive fills any such tunnel voids and, therefore, eliminates stress concentrations that are caused by tunnel voids.

## **VI. ISSUES**

Claims 1, 4, and 6- 9 are rejected under 35 U.S.C. 102(b) as being anticipated by *Matsen*, U.S. Patent 6,040,563.

Claim 6 is rejected as being obvious under § 103(a) in view of U.S. Patent 6,040,563 (*Matsen*) based on Applicant's Admitted Prior Art (AAPA).

## **VII. GROUPING OF CLAIMS**

Each claim stands separately; arguments for the patentability of each claim appear in the Argument section.

## **VIII. ARGUMENT**

### **Rejection under § 102(b)**

*Matsen* describes a bonded assembly. The Examiner asserts that *Matsen* teaches a polyimide film adhesive at column 10. *Matsen* reads:

The present invention [i.e., bonded thermoplastic resin composites as shown in Fig. 4 of US 6,040,563] is applicable to all types of organic matrix composites including both thermosetting and the thermoplastic composites such as epoxies, bismaleimides, polyimides, PEEK, PEK, PEKK, PES, or the like. If the materials have high solvent concentrations or the resins emit volatiles when they cure, we need to "bag" the workpiece to permit egress of these volatiles. Therefore, we prefer using resins with low volatiles that are true thermoplastics, like PEEK.

We can bond metals in a comparable process that we will describe in greater detail in section 4.

### **3. Bonding, (i.e., curing) Thermosetting Resin Composite Honeycomb Panels**

Fig. 6 illustrates the bonding of thermoset facesheets 300 and 302 to a honeycomb core 304 using an adhesive film 306 in a cobond operation.

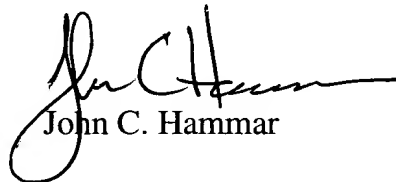
Neither the bonded thermoplastic resin composites nor the resin composite honeycomb panels have the structure defined in the claims and shown in Fig. 4 of the present application. That structure has adhesive between a superplastically formed core of metal sheets and superplastic face sheets. *Matsen* uses susceptor sheets, but it does not

bond metal-to-metal with a high temperature polymer film adhesive. Please reconsider the rejections based upon *Matsen*.

Rejection under § 103(a)

*Matsen* has the deficiencies noted with respect to the 102(b) rejections. There is no AAPA. If there were, such AAPA would not cure the deficiencies of *Matsen*. If the Examiner's reasoning were correct, any combination would be unpatentable for obviousness because it would be merely the assembly of known elements. While the noted alloys exist, there is no teaching to use them in a method of the type Applicant claims, other than Applicant's own teaching. The Applicant's method cannot rightly be rejected over Applicant's own teaching. Since *Matsen* does not teach or suggest a core made from superplastically formed metal sheets, *Matsen* plus the alleged AAPA does not teach the claimed invention.

Respectfully submitted,



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206-544-1059

## **IX. APPENDIX**

*The appealed claims are:*

1. A method for making a multisheet sandwich panel having a superplastically formed core of metal sheets; adhesively bonded with a polymer film to outer metal face sheets; being formable superplastically in a superplastic forming temperature range, comprising the steps of:

- (a) assembling a pack of a plurality of sheets of sheet metal having outer metal face sheets and a high temperature polymer film adhesive affixed to at least one sheet in the pack at selected locations corresponding to the location of adhesive bonds between a face sheet and the core in the finished part;
- (b) loading the pack to a press;
- (c) heating the pack to the superplastic forming range without destroying the polymer film adhesive;
- (d) superplastically forming the pack to define a selected core geometry for the finished part and to define polymer film adhesive bonds;
- (e) flowing the polymer film adhesive concurrently with forming the pack to produce polymer film adhesive bonds in desired locations;
- (f) cooling the formed pack below the superplastic range to a temperature where the polymer film adhesive sets to complete the finished part; and
- (g) removing the cooled, finished part from the press.

2. The product obtained by the SPF/AB method of claim 1.

3. The product of claim 2 wherein the sheets are aluminum alloy and the adhesive is a polyimide.

4. A combined cycle method for superplastically forming and adhesively bonding a multisheet part, especially one having aluminum face sheets and core sheets, with a polymer film adhesive comprising the step of:

adhesively bonding using a polymer film adhesive between an aluminum core pack and aluminum outer face sheets in the part while superplastically forming the core pack.

5. An SPF/AB part made by the method of claim 4.
6. The process of claim 1 wherein the metal sheets are A1 2004, A1 8090, or A1 1570 and the adhesive is a polyimide.
7. The method of claim 4 wherein the adhesive is a polyimide.
8. The method of claim 1 wherein forming occurs below 425°C.
9. The method of claim 4 wherein forming occurs below 425°C.